



PORTLAND HARBOR RI/FS  
**APPENDIX N**  
**GREEN REMEDIATION**  
**DRAFT FEASIBILITY STUDY**

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March 30, 2012

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## LIST OF ACRONYMS

ASTSWMO	Association of State and Territorial Solid Waste Management Officials
ASTM	American Society for Testing and Materials
BA	Biological Assessment
BMP	Best Management Practice
CAD	Confined Aquatic Disposal
CAG	Community Advisory Group
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFL	Compact Fluorescent Lights
CO <sub>2</sub>	Carbon Dioxide
CO	Carbon Monoxide
CWA	Clean Water Act
DERA	Diesel Emission Reduction Act
DEQ	Oregon Department of Environmental Quality
EFH	Essential Fish Habitat
EMNR	Enhanced Monitored Natural Recovery
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FFEO	Federal Facilities Enforcement Office
FFRRO	Federal Facilities Restoration and Reuse Office
FRTR	Federal Remediation Technologies Roundtable
FS	Feasibility Study
GHG	Greenhouse Gas
ITRC	Interstate Technology and Regulatory Council
LWD	Large Woody Debris
LUST	Leaking Underground Storage Tanks
LWG	Lower Willamette Group
MNR	Monitored Natural Recovery
NCP	National Contingency Plan
NO <sub>x</sub>	Nitrogen Oxide
NxEAT	Nitrous Oxide Energy Assessment Tool
OEM	Office of Emergency Management
OHW	Ordinary High Water
OLW	Ordinary Low Water
OSRE	Office of Site Remediation Enforcement
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	EPA Office of Solid Waste and Emergency Response
OWEB	Oregon Watershed Enhancement Board
PM	Particulate Matter
PV	Photovoltaic
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
SELP	State Energy Loan Program

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SO <sub>x</sub>	Sulphur Oxide
SURF	Sustainable Remediation Forum
VOC	Volatile Organic Compounds

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## EXECUTIVE SUMMARY

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In order to comply with EPA Section 10 requirements to consider green remediation opportunities as a potential means to reduce the environmental footprint of the remedial action, the Lower Willamette Group (LWG) reviewed current green remediation guidance and policy, identified green remediation technologies and practices, and evaluated their applicability and feasibility to the remedial alternatives as identified in the draft FS.

While green remediation opportunities should be considered as part of the FS, the primary objective of remediation is to achieve the RAOs, and the alternative selection process is not driven by green remediation considerations. EPA promotes environmental stewardship during remedial actions by applying green remediation technologies and practices within a green remediation framework including five green remediation core elements:

- Total Energy and Renewable Energy Use
- Air Pollutants and Greenhouse Gas (GHG) Emissions
- Water Use and Impacts to Water Resources
- Materials Management and Waste Reduction
- Land Management and Ecosystem Protection

The various alternatives were evaluated against these five core elements and subsequently ranked according to the size of their environmental footprints. The environmental footprint size of the various alternatives appears to be determined by the type and proportion of the remedial technologies used, with monitored natural recovery (MNR) having the smallest environmental footprint of any individual remedial technology. While all of the alternatives include MNR for the majority of the Site, the extent of MNR versus other more intensive remedial technologies varies by alternative, and alternatives with the greatest extent of dredging, associated upland disposal, and engineered capping, have the largest environmental footprints.

The inherent environmental footprint rankings of the various alternatives were re-evaluated and ranked after varying degrees of green remediation technologies and practices were applied. It was found that the degree of implementation of green technologies and practices can moderately influence the overall environmental footprint of each alternative.

If 100 percent of green technologies and practices were applied to the alternatives, the greenest alternative appears to be Alternative C-r, which has relatively high amounts of MNR, does not use in situ treatment, has relatively low amounts of dredging and capping, and has a substantial volume placed in on-Site CDFs rather than upland disposal. The least green alternative in this analysis is Alternative F-r, which contains significant amounts of dredging, capping, and upland disposal of a majority of the dredge material volume.

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If 50 percent or 25 percent of green technologies and practices were applied, Alternative C-r drops to the fifth rank, and Alternative B-i becomes the greenest ranked option because of its emphasis on MNR, resulting in relatively low amounts of dredging and capping, and because it has the lowest total disposal volume of all of the alternatives.

The application of green remediation opportunities may reduce the environmental footprints of the various alternatives, but the consideration of these opportunities is not intended to determine the selection of the alternative; rather, the green remediation principles are applied with the intention of reducing the environmental footprint of the selected alternative.

## 1.0 INTRODUCTION

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The U.S. Environmental Protection Agency (EPA) Region 10 requires that green remediation strategies be incorporated into remedial actions to possibly minimize their environmental footprint and achieve greater net environmental benefits (EPA 2008a). The current focus of green remediation strategies is on innovation in remedial technologies and practices. This appendix describes technologies and practices that may be used to possibly optimize existing remedial systems in the remedial alternatives in the draft Feasibility Study (FS) and lower the environmental footprint of cleanup actions associated with the Portland Harbor remedial action within EPA's jurisdiction.

The draft FS contains a range of remedial alternatives for the Portland Harbor Superfund Site that represents varying combinations of remediation spatial extent and technology approaches that have the potential to achieve remedial action objectives (RAOs).

These remedial action alternatives place demands on the environment. They require energy, water, materials, and natural resources. They release pollutants and greenhouse gas (GHG); and generate waste to accomplish RAOs. This appendix identifies the opportunities and potential to reduce the environmental side effects of remediation through the green remediation strategies described herein.

## 2.0 PURPOSE OF DOCUMENT

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In order to comply with EPA's requirements, the Lower Willamette Group (LWG) reviewed current green remediation guidance<sup>1</sup> and policy, identified green remediation technologies and practices, and evaluated their applicability and feasibility to the remedial alternatives as identified in the draft FS.

While human health and ecological risk reduction and evaluation against the nine Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) FS criteria will be the determining factors in identifying the most appropriate alternative to achieve RAOs, the integration of principles of green remediation is intended to potentially help reduce the environmental footprint of the EPA-selected alternative.

This document is intended to identify which green technologies and practices could be applied in an effort to reduce the project's environmental footprint while achieving the RAOs. The various alternatives were evaluated and ranked according to the size of their environmental footprint before and after incorporation of green remediation technologies and practices. Methods to determine the relative environmental footprint of each of the remedial alternatives are preliminary and qualitative based on information available in the draft FS and best professional judgment.

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<sup>1</sup> This document is based on guidance and documentation available before September 16, 2011, and therefore does not include the "Draft Methodology for Understanding and Reducing a Project's Environmental Footprint," published by the EPA on September 16, 2011 (EPA 2011d). However, this new guidance may be incorporated into subsequent drafts of this document.

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## 3.0 GREEN REMEDIATION GUIDANCE, POLICY AND DEFINITIONS

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### 3.1 DEFINITIONS

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#### 3.1.1 Green versus Sustainable Remediation

The EPA defines green remediation as “the practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of cleanup actions.” (EPA 2010a)

The focus of green remediation is environmental stewardship applying current and updated technologies and practices to remedial actions in order to maximize net environmental benefits. These technologies and practices are referred to as “green” due to their emphasis on reducing the environmental footprint of the cleanup action. The term “green” is also used to distinguish these technologies and practices from “remedial technologies” that cover the various potential methods used to implement environmental cleanup as described in this appendix and in Section 6.0 the draft FS. Green remediation practices typically implement Best Management Practices (BMPs) related to use of materials, energy and water, output of emissions and waste, and protection of natural resources.

Sustainable remediation is a broader term that considers environmental factors as well as community impacts integrating *economic, ecological, and social* implications of remedial actions, which is commonly referred to as the “triple bottom line”<sup>2</sup> of sustainability. Sustainable remediation reaches beyond the technologies and practices of environmental stewardship associated with green remediation (ITRC 2011).

While the terms green and sustainable remediation are oftentimes used interchangeably, they differ significantly in their scope. Therefore, the focus of this document is on green remediation technologies and practices as defined by the EPA. It addresses reduction of energy and water consumption, the emission of air pollutants and GHGs, and general conservation of resources (EPA 2010a and EPA 2008a).

### 3.2 GREEN REMEDIATION REGULATORY FRAMEWORK

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The development of a green remediation strategy is a continuously evolving process. Guidance and policies are being developed in response to environmental obligations and commitment on the state and federal level, as well as in response to the rapid rise of awareness about and innovation of green remediation technologies and practices.

The green remediation guidance and policies developed by the EPA are based on existing statutory and regulatory frameworks across all cleanup programs including CERCLA and National Contingency Plan (NCP), as well as on the EPA Strategic Plan, executive

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<sup>2</sup> Organizations using a triple bottom line strategy measure and report on factors such as carbon footprint, community outreach, and health and safety as well as market position and shareholder value. It is at the intersection of economic, environmental and social performance that sustainability occurs (USGBS 2011).

orders, other federal and state statutes and regulations addressing green and sustainable practices including the following:

- Energy Policy Act of 2005
- Energy Independence and Security Act 2007
- American Recovery and Reinvestment Act 2009
- Executive Order (EO) 13514, *Federal Leadership in Environmental, Energy and Economic Performance*, 2009
- Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy and Transportation Management*, 2009

A number of guidance documents and policies were developed by EPA to promote greener approaches to remediation as discussed in the following subsection.

### 3.2.1 EPA Superfund Green Remediation Strategy

The EPA Superfund green remediation strategy addresses policy and guidance development, as well as resource development, and program implementation, and evaluation. Its goal is to promote green remediation practices for cleanups without compromising cleanup goals and objectives.

A green remediation primer, “*Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites*,” was published by the EPA in 2008 (EPA 2008a). This document provides an overview of green remediation as well as establishes its core elements consisting of energy, air, water, land and ecosystems, materials and waste, and stewardship.

In September 2008, EPA formed the Superfund Green Remediation Workgroup chaired by the Office of Superfund Remediation and Technology Innovation (OSRTI) to develop policy and technical resources towards implementation of a green remediation strategy for cleanup actions. The workgroup includes the Office of Emergency Management (OEM), the Federal Facilities Restoration and Reuse Office (FFRRO), the Office of Site Remediation Enforcement (OSRE), the Federal Facilities Enforcement Office (FFEO), and Superfund Offices in Regions 1 through 10.

Two guidance documents that were developed by the EPA workgroup identify actions to promote green remediation related to policy and guidance development, resource development and program implementation, and evaluation. The *Superfund Green Remediation Strategy*, was first published in August 2009 (EPA 2009c), and the final strategy was published in September 2010 (EPA 2010a) after public comment was received on the first document published in 2009. The final document includes an appendix with 30 implementation actions to integrate green remediation principles into the Superfund program.

### 3.2.2 EPA OSWER Policy: Principles for Greener Cleanups

The most current information published on EPA's website (<http://www.epa.gov/oswer/greencleanups/principles.html>; accessed on July 18, 2011) references the *Principles for Greener Cleanups* published in 2009 by the EPA Office of Solid Waste and Emergency Response (OSWER) as the current EPA policy for evaluating and minimizing the environmental footprint of remedial actions.

OSWER's policy (EPA 2009e) is consistent with existing laws and regulations requiring that cleanup actions:

- Protect human health and the environment
- Comply with all applicable laws and regulations
- Consult with communities regarding response action impacts consistent with existing requirements
- Consider the recommended five core elements of green remediation:
  - Total energy and renewable energy use
  - Air pollutants and GHG emissions
  - Water use and impacts to water resources
  - Materials management and waste reduction
  - Land management and ecosystem protection

These core elements are applicable to all phases of work associated with a remedial action, including site investigation, development of cleanup alternatives, and remedy design, construction, operation, and monitoring (EPA 2010a).

While the principles of green remediation are intended to help achieve the cleanup goals and objectives of a project by potentially reducing the environmental footprint of the remedial action, protecting human health and environment is the primary goal of remediation and remains the determining factor in the remedial action decision making process. Therefore, green remediation should be applied without "compromising cleanup objectives, community interests, the reasonableness of cleanup timeframes, or the protectiveness of the cleanup actions" (EPA 2009e).

### 3.2.3 EPA Region 10: Green and Clean Policy

Green remediation policies vary for the 10 different EPA regions. Guidance and recommendations sharing common elements for incorporating green remediation principles into cleanup projects are in place in all of the 10 EPA regions, but only Regions 2 and 10 require green remediation to be incorporated into cleanup projects.

In 2009, Region 10 developed a "Green and Clean Policy" that is applicable to all Superfund cleanup projects in the region with the goal to promote the application of green or sustainable practices and technologies to remedial actions. While this policy

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does not “fundamentally change how and why cleanup decisions are made” it “calls for more sustainable methods of implementing those cleanups” (EPA 2009d).

The main objectives of this policy are as follows:

- Protect human health and the environment by achieving remedial action goals
- Support sustainable human and ecological use and reuse of remediated land
- Minimize impacts to water quality and resources
- Reduce air toxics emissions and GHG production
- Minimize material use and waste production
- Conserve natural resources and energy

This policy details cleanup practices that are encouraged, such as use of renewable energy and energy conservation, use of cleaner fuels and emissions reduction strategies, water conservation and efficiency, incorporation of sustainable site design, reuse and recycling of materials, support of GHG emissions reduction technology, and others (see Region 10 Superfund, Resource Conservation and Recovery Act [RCRA], Leaking Underground Storage Tanks [LUST], and Brownfields Clean and Green Policy; EPA 2009d)

### **3.2.4 Other Agencies and Partner Organizations**

EPA is collaborating with a number of other agencies and private entities in the development of green remediation policy, guidance, practices, and technologies. These include the Federal Remediation Technologies Roundtable Project (FRTR), the Sustainable Remediation Forum (SURF), the Association of State and Territorial Solid Waste Management Officials (ASTSWMO), and American Society for Testing and Materials (ASTM) International.

## 4.0 SOURCES OF INFORMATION AND TOOLS

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### 4.1 GUIDANCE DOCUMENTS AND WEB SITES

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The main guidance documents utilized to develop and organize this appendix include:

- Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites; USEPA, April 2008 (EPA 2008b)
- Superfund Green Remediation Strategy, USEPA, September 2010 (EPA 2010a)

The following websites and documents were reviewed for additional information regarding green remediation:

- <http://www.clu-in.org/greenremediation/>
- [http://www.itrcweb.org/teampublic\\_GSR.asp](http://www.itrcweb.org/teampublic_GSR.asp)
- <http://www.sustainableremediation.org/>
- [http://www.dtsc.ca.gov/omf/grn\\_remediation.cfm](http://www.dtsc.ca.gov/omf/grn_remediation.cfm)
- Region 10 Superfund, RCRA, LUST, and Brownfields: Clean and Green Policy, USEPA, August 2009; accessed Greener Cleanups. Contracting and Administrative Toolkit, EPA OSWER & OSRTI, January 2011 update (EPA 2009d)
- Green Cleanup Standard Initiative project update of September 2009 (EPA 2009f)
- Sustainable Remediation White Paper: Integrating Sustainable Principles, Practices, and Metrics into Remediation projects (SURF 2009)
- Green Remediation Best Management Practices: Integrating Renewable Energy into Site Cleanup, EPA OSWER, April 2011 (EPA 2011b)
- Green Remediation Best Management Practices: Clean Fuel & Emission Technologies for Site Cleanup, EPA OSWER, August 2010 (EPA 2010b)
- Green Remediation Best Management Practices for Excavation and Surface Restoration, OSWER, December 2008 (EPA 2008b)
- Green and Sustainable Remediation: State of the Science and Practice; ITRC, May 2011 (ITRC 2011)
- Other documents (see References Section 9.0).

### 4.2 TOOLS

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A wealth of non-proprietary tools that evaluate green remediation opportunities for a project are available. More detailed summaries of these resources are available in Appendix A of the ITRC's *Green and Sustainable Remediation: State of the Science and Practice* (ITRC 2011), listed above:

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- ATHENA Impact Estimator for Buildings:  
<http://www.athenasmi.org/tools/impactEstimator/>
- ATHENA Eco Calculator for Assemblies:  
<http://www.athenasmi.org/tools/ecoCalculator/index.html>
- BEES - Building for Environmental and Economic Sustainability:  
<http://www.nist.gov/el/economics/BEESSoftware.cfm>
- Diesel Emissions Quantifier: <http://cfpub.epa.gov/quantifier/> and  
[www.epa.gov/otaq/diesel/documents/appl-fleet.xls](http://www.epa.gov/otaq/diesel/documents/appl-fleet.xls)
- EMFACT – Energy and Materials Flow and Cost Tracker:  
<http://www.newmoa.org/prevention/emfact/about.cfm>
- Green Remediation Evaluation Matrix:  
[http://www.dtsc.ca.gov/OMF/Grn\\_Remediation.cfm](http://www.dtsc.ca.gov/OMF/Grn_Remediation.cfm)
- Greener Cleanups Matrix: <http://www.epa.state.il.us/land/greener-cleanups/matrix.pdf>
- GREET – Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation: <http://greet.es.anl.gov/main>
- Greenscapes:  
<http://www.epa.gov/epawaste/conserve/rrr/greenscapes/tools/index.htm>
- Hybrid2 – Hybrid Power System Simulation Model:  
[http://www.umass.edu/windenergy/OLD\\_SITE/projects/hybrid2/index.html](http://www.umass.edu/windenergy/OLD_SITE/projects/hybrid2/index.html)
- IWEM – Industrial Waste Management Evaluation Model:  
<http://www.epa.gov/epawaste/nonhaz/industrial/tools/iwem/index.htm>
- PaLATE – Pavement Life-Cycle Assessment Tool for Environmental and Economic Effects: <http://www.ce.berkeley.edu/~horvath/palate.html>
- PTT – Performance Tracking Tool:  
<http://www.afcee.af.mil/shared/media/document/AFD-100113-032.xls>
- RETScreen – Clean Energy Project Analysis Software:  
<http://www.retscreen.net/ang/home.php>
- SRT – Sustainable Remediation Tool:  
<http://www.afcee.af.mil/resources/technologytransfer/programsandinitiatives/sustainableremediation/index.asp>
- WARM – Waste Reduction Model:  
[http://epa.gov/climatechange/wycd/waste/calculators/Warm\\_home.html](http://epa.gov/climatechange/wycd/waste/calculators/Warm_home.html)

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## 5.0 GREEN REMEDIATION – RELEVANCE TO PORTLAND HARBOR DRAFT FS

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### 5.1 PROPOSED ACTION SUMMARY

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For this document, the proposed action consists of the remedial activities or technologies that could occur as part of the selected alternative within the Site. Specifically, the elements of the proposed action could include:

- Monitored natural recovery (MNR)
- In-place technologies
  - Enhanced monitored natural recovery (EMNR)
  - In situ treatment
  - Engineered cap or active cap
- Dredging
- Ex situ treatment of sediments before disposal (e.g., dewatering, stabilization, and potentially some other ex situ treatment technologies that could be implemented in remedial design/remedial action)
- Transport and disposal of dredged material (upland, confined disposal facility [CDF], confined aquatic disposal [CAD])
- Removal and installation of piling and structures

These technologies are described in detail in draft FS main text Section 6.0.

### 5.2 GREEN REMEDIATION CORE ELEMENTS

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Recognizing that site cleanup creates an environmental footprint of its own, EPA's main objective of green remediation is to minimize this footprint and promote environmental stewardship during remedial actions. Five core elements of green remediation provide a framework for a discussion of best management practices (BMPs) that may lead toward this objective. This document is organized by these core elements, which include:

- Total Energy and Renewable Energy Use: reducing total energy use and increasing the percentage of energy from renewable resources
- Air Pollutants and GHG Emissions: reducing air pollutants and GHG emissions
- Water Use and Impacts to Water Resources: reducing water use and negative impacts on water resources
- Materials Management and Waste Reduction: improving materials management and waste reduction efforts
- Land Management and Ecosystem Protection: protecting ecosystem services during Site cleanup

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The subsequent sections will rank each remedial technology based on its potential environmental footprint and identify opportunities for green remediation technologies and practices. These subsequent sections will describe specific green technologies and practices for each core element that can potentially be applied to each remedial technology.

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## 6.0 GREEN REMEDIATION RANKING OF REMEDIAL TECHNOLOGIES

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### 6.1 INTRODUCTION

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The green remediation core elements collectively provide a system for evaluating the inherent sustainability of various remedial technologies and provide options for potentially reducing the environmental footprint of these remedial technologies. Table 6-1 ranks the conventional remedial technologies based on their potential environmental footprint and also illustrates how applying green opportunities to each technology would potentially affect this ranking. Because some green remediation core elements contain multiple elements (e.g. Total Energy Use and Renewable Energy Use), some have been split into sub-elements within the table to show this level of detail. The following subsections describe in detail the rationale for the rankings of the remedial technologies against each core element. They also describe various green remediation opportunities that can be applied to the remediation technologies. The green remediation opportunities include green technologies and green practices, which are described in each subsection below.

The combination of the remedial technologies makes up each of the remedial alternatives. The overall green remediation ranking of each remedial alternative and how applying green opportunities to each technology would potentially affect this ranking is presented in Section 7.0.

The remedial technology with the smallest environmental footprint is MNR, followed by EMNR) and in situ treatment. Dredging, capping, and the associated disposal and structure installation and removal all have relatively larger environmental footprints. This analysis does not yet utilize footprint calculation procedures recently released from EPA (*Draft Methodology for Understanding and Reducing a Project's Environmental Footprint*, published by the EPA on September 16, 2011 [EPA 2011d]). Qualitative analysis of each remedial technology for rankings in this draft relied on information in other sections of the draft FS and EPA green remediation guidance documents. Further detail for these rankings can be found within the *Rationale for Remedial Technology Rankings* subsections below.

Green remediation opportunities exist for all remedial activities to varying degrees. However, because of their relatively larger footprints, the greatest overall opportunities for implementing green remediation practices can be found in the dredging, capping, and sediment transportation technologies. While the application of green remediation technologies and practices may lead to significant reductions of larger footprints, it does not necessarily translate into an overall smaller environmental footprint compared to other remedial technologies that may be inherently greener. For instance, in comparing MNR to dredging, the potential reductions in the dredging environmental footprint are unlikely to amount to fewer effects than the inherently smaller footprint of MNR. More analysis in the remedial design phase is required to quantify potential environmental footprint reductions from employing green technologies and practices to specific

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remedial technologies. Further detail for these rankings can be found within the *Rationale for Green Remediation Opportunity Rankings* subsections below.

## 6.2 TOTAL ENERGY AND RENEWABLE ENERGY USE

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### **Rationale for Remedial Technology Rankings**

Significant amounts of energy, specifically diesel fuels and to a much smaller extent, electricity, are expected to be consumed to power equipment, facilitate transport operations, and run Site operations associated with the proposed remedial technologies. The highest energy consumption is anticipated for remedial alternatives involving the most dredging and transportation of sediments for disposal, and to a lesser degree, materials for remediation such as capping. The lowest energy use remedial technologies are anticipated for MNR, EMNR, and in situ treatment.

Appendix Ic to the draft FS illustrates the specific emission volumes by alternative, which can be carried over to illustrate petroleum fuel consumption. The appendix also shows which remedial technologies will produce the most emissions and consume the most fuel within each Alternative. Figure 1a of Appendix Ic indicates that the largest total carbon dioxide (CO<sub>2</sub>) emissions occur within Alternatives F-r and F-i. Figure 1b of Appendix Ic further illustrates that the source of these high emissions is mostly rail transport for upland disposal (for Alternative F-r) and dredging activities for Alternative F-i. Examining the remaining alternatives indicates that the remedial technologies with the greatest emissions are generally rail transport for upland disposal of dredged sediment, dredging activities, transportation of capping materials, and capping activities.

Appendix Ic summary Table 2 illustrates the construction activities and remedial technologies that contribute very small volumes of emissions. These include Site preparation, which will be necessary to varying but relatively equal degrees for all alternatives. It also includes in situ treatment, which also has relatively equal amounts of energy consumption between alternatives.

Besides fuels, electricity use will also contribute to the total energy consumption of the project. However, the magnitude of electricity to fuel use is anticipated to be relatively small, especially because long-term treatment activities such as pump and treat are not included within the project. In addition, while monitoring activities and the powering of staging area infrastructure will include further electrical consumption, this technology and construction activities will be included as part of all of the alternatives.

### **Rationale for Green Remediation Opportunity Rankings**

In general, the greatest opportunities for employing green remediation practices related to energy are associated with the technologies with the largest environmental energy footprint. Therefore, for active remediation on-Site, dredging and capping may provide the most opportunities for practices to reduce energy use and maximize substitutions of renewable sources of energy.

Maximizing the use of renewable energy and reducing energy consumption has significant potential to reduce the overall environmental footprint of all remedial actions. Current EPA guidance emphasizes substituting fossil fuels with alternative fuels as the primary approach for addressing energy conservation in the context of green remediation. Lowering consumption of fossil fuels will also result in benefits to air quality by reducing emissions of GHGs (see draft FS Appendix Ic), as well as of particulate matter (PM) and other air pollution (EPA 2011b)

Although for the purposes of alternative development, costing, and air emission estimates, the assumption of typical fuel use and prices is used (see draft FS Appendix Ic, Section 2), the use of renewable energy is broadly estimated to be possible for 10 to 25 percent of this energy. Currently ASTM D975 allows a 5 percent by volume blend of biodiesel with diesel fuel. A more recent specification (ASTM D7467) allows for up to a 20 percent blend (National Renewable Energy Laboratory 2009). It is broadly estimated that total emissions of each alternative could be reduced by 7 to 20 percent; however, this would potentially increase cost of fuel by 50 to 75 percent. This emissions estimate is based on the assumption that biodiesel has emissions that are reduced by 78 percent from petrodiesel emissions (National Biodiesel Board 2011). The cost comparison is based on a study from 2004; however, this cost comparison may be outdated especially in its assumption of relatively immobile petrodiesel costs over time (Energy Information Administration 2004).

In addition to employing renewable energy sources, maximizing local upland disposal and CAD/CDF disposal may also contribute to a smaller footprint, thus providing another option towards more sustainable remediation. Remedial technologies that use relatively less energy provide fewer opportunities for reduction of energy use; this is true especially of MNR and EMNR, although even with these technologies, employing renewable energy or energy-saving practices during monitoring activities is still an option. In general, planning for and monitoring energy demands of equipment and supporting infrastructure associated with cleanup operations provides opportunities to integrate green technologies and practices into the project, which may also result in cost savings.

### **6.2.1 Green Technology Opportunities (Energy Technologies/Fuels)**

Substituting alternative and renewable sources of energy for fossil fuel may help lower the environmental footprint of the proposed action and reduce harmful pollutant emissions, including GHG and PM. Remedial activity within some SMAs could have a fairly long timeline (more than 30 years) for initiation, and thus the availability of renewable energy sources may be even greater when construction activities begin. Renewable energy technologies that could be utilized or in some cases produced on-Site include:

- Geothermal energy, through geothermal pumps that access subsurface reservoirs of hot water
- Solar resources through the use of photovoltaic (PV) systems

- Wind resources through the use of turbines or windmills that can generate electricity
- Hydrokinetic and marine resources that can use tides to generate electricity
- Biomass energy that uses vegetative, wastewater, anaerobic, and animal waste for heating or electricity generation (EPA 2008a).

Producing renewable energy on-Site may provide benefits through all stages of the Site investigation and remediation. The first step towards this action involves producing a renewable energy assessment that examines the energy needs of the cleanup, the opportunities within the Site for producing energy resources, existing infrastructure that can be used for the system, potential locations on-Site to place systems, the estimated output and cost of different energy systems, and an evaluation of pertinent government utility incentives applicable to the project.

Opportunities for on-Site production may include:

- Small-scale forms of renewable energy, especially for small sampling equipment and other portable devices
- Designing medium or large-scale systems that can meet all of the energy demand during the proposed action and can be repurposed for future land use after remediation
- Using hybrid systems to produce power using multiple sources (EPA 2011b)

Applications for renewable energy use may include:

- Using solar-powered telemetry systems to transmit logging data
- Using small PV systems to power auxiliary equipment such as electricity generators, landscaping tools, and weather stations
- Using rechargeable batteries for handheld devices used in the field (EPA 2009b)
- Utilizing geothermal pumps, powered by simple ground heat exchanger systems to condition air within on-Site buildings.
- Retrofitting standard diesel generators to recover, store and reuse “waste heat” (EPA 2010b)

Cleaner fuels include those that burn diesel with fewer emissions (including biodiesel) and other fuels such as propane and natural gas, some examples include:

- Ultra-low sulfur diesel, which is further refined than conventional diesel and can be used in any diesel engine. This fuel will be required for locomotive and marine use in 2012 and is already required for highway and non-road use.
- Biodiesel/renewable diesel, which is created from animal fats and new and used vegetable oils. Biodiesel is biodegradable and reduces emissions of PM, carbon

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monoxide (CO), and hydrocarbons; however, nitrogen oxide (NO<sub>x</sub>) emissions are increased with this fuel.

- Emulsified diesel, which is a mixture of diesel, water, and other additives causing a lower combustion temperature. PM and NO<sub>x</sub> emissions are reduced through the use of this product.
- Liquefied petroleum gas or propane, which is a byproduct of natural gas production. This fuel requires a dedicated engine; forklifts and loaders often are powered from this fuel (EPA 2011c).

Of these clean fuel options, utilizing biodiesel or biodiesel blends within construction equipment is likely the most available and feasible option.

Fuel additives may also be used to increase fuel efficiency and lower air emissions from diesel engines. Those additives recommended by the EPA include:

- Emulsified diesel such as the PuriNox product can reduce emissions of PM and NO<sub>x</sub> emitted from heavy-duty 2- and 4-stroke engines
- Cetane enhancers can also reduce NO<sub>x</sub> emissions
- Platinum-based fuel additives are currently being studied and may also provide emission benefits (EPA 2010b)

## 6.2.2 Green Practice Opportunities

Green remediation BMPs related to energy consumption focus on minimizing total energy use and maximizing use of renewable energy. The environmental benefits of this approach to energy consumption may also benefit air quality because reduced energy consumption results in lower emissions. Potential BMPs to be applied, as practicable, include the following:

- To address the findings of draft FS Appendix Ic, Section 4.1 that transporting materials for capping may contribute to significant fuel use and thus emissions, local sourcing (less than 100 miles from the Site) of capping materials should be maximized.
- To address the conclusions of Appendix Ic, Section 4.2 that transport to upland disposal options significantly impact emissions and thus fuel use, in-water CDF or CAD disposal should be maximized and transport of materials outside of the local area should be minimized.
- For any necessary transport outside the local area, train transport should be favored over transport by barge or truck.
- Dredging activities should be carefully monitored to ensure that unintentional overdredging, and thus increased dredge volumes, are minimized.
- Renewable energy sources available for remediation may be incorporated into treatment systems and Site operations to meet partial or full energy demands, for

production of electricity or as direct power. Alternative fuel vehicles (e.g., hybrid-electric, or ultra low sulfur diesel) or biodiesel blends may be used within existing diesel engine equipment.

- Materials manufactured using renewable energy may be used.
- Energy consumption should be routinely tracked through utility provided meters and no cost tracking tools such as the NO<sub>x</sub> and Energy Assessment Tool (NxEAT) and other government or non-profit organization provided tools, or commercially available software, leads to a better understanding and more accurate monitoring of energy consumption (EPA 2011a).
- Energy cost may be reduced by operating energy intensive systems during non-peak hours. This may also alleviate demands on the power grid during peak time.
- Treatment processes may be routinely evaluated for optimal performance and optimization; this could potentially lead to possible equipment downsizing or shutoff.
- Local (within 100 mile radius or less) services and materials may be used.
- Work may be scheduled and sequenced to minimize travel and double handling of materials.
- Routine maintenance, inspections, and repairs of industrial equipment should be conducted.
- An idle reduction plan for construction equipment should be implemented.
- Free product or emissions may be captured for on-Site energy recovery.
- Energy efficient systems and office equipment such as “Energy Star” equipment and compact fluorescent lights (CFL) may be used in the job trailer. Heating and cooling systems should be maintained in optimum conditions.

### 6.2.3 Technical and Financial Assistance

The Oregon Department of Energy manages the State Energy Loan Program (SELP), which provides low-interest loans for programs that promote energy conservation, renewable energy, or the use of recycled products. Government programs that evaluate emerging technologies include the National Clean Diesel Campaign, which is managed by EPA. Similarly, Oregon has a Clean Diesel Initiative that can provide both technical and financial assistance for retrofitting engines. Other emissions-reduction funding sources include the Federal Diesel Emission Reduction Act (DERA) signed by the President in January 2011. DERA provides grants to state, local, and tribal governments for emission reduction programs. Oregon Department of Environmental Quality (DEQ) also manages grants and tax credits for diesel retrofitting through the Air Quality Clean Diesel Program.

## 6.3 AIR POLLUTANTS AND GHG EMISSIONS

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### Rationale for Remedial Technologies Ranking

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Conventional remediation would involve a significant amount of gasoline, diesel, and other fuels to power equipment. These fuels release air pollution that contributes GHG and PM into the atmosphere. Volatile organic compounds (VOCs) may also be mobilized through field generation of dust. The expected air emissions associated with each remedial alternative are detailed in draft FS Appendix Ic and summarized in the energy ranking discussed in Section 6.2. Generally, the greatest emissions will occur through dredging and rail/upland transportation of waste, transportation of capping materials, and capping activities.

### **Rationale for Green Opportunity Ranking**

As discussed in the energy ranking in Section 6.2, the greatest opportunities for green remediation related to emissions will fall under those technologies with the greatest environmental footprints: dredging, upland transportation, importing of capping material, and capping activities. The remedial technologies with the smallest opportunities for reduction of impacts are those with the smallest fuel use, namely MNR, EMNR, and in situ treatment.

#### **6.3.1 Green Technology Opportunities (Energy Technologies/Fuels)**

Opportunities for reducing air emissions may be found in the choice of equipment and green technologies used for the remedial action. While fuel and fuel additive choices may also contribute to reduced air pollutant emissions, this topic has already been addressed in the energy ranking in Section 6.2.

A recent comparison of mechanical and hydraulic dredging methods with respect to air emissions found that mechanical dredging is better suited for projects with lower volume dredging (less than 1,000 cubic yards [cy]) or higher transport distances (greater than 3 miles) than hydraulic technology (Anderson and Barkdoll 2010). As discussed in the draft FS Section 2.9, it is likely that remedial action at this Site will take place through a series of relatively smaller projects, likely on a SMA-by-SMA basis. While the dredging volumes, even at the SMA level, will be much higher than 1,000 cy, the transport distances for the majority of dredging will also be much greater than 16,000 feet. Because these distances would require double-handling of dredge spoils, the mechanical method would produce lower air emissions than the hydraulic method. If a final disposal site nearby or within an SMA dredging area is used, (e.g., CAD or CDF within the SMA), the hydraulic dredging method would likely have a lower air emissions impact than mechanical dredging.

Development and use of low-emission dredging equipment for large-scale removal projects is still in its infancy. For smaller projects near the shore, an electric dredge connected to shore power may be a possible alternative and may be suitable for construction of some SMAs with shoreline access and substantial amount of near-shoreline contaminated sediments. In December 2010, a sustainable dredge test was successfully completed in The Netherlands by IHC Merwede. The standard cutterhead hydraulic dredge tested was the first to use hydrogen (fuel cell) power. The use of fuel cells in dredging is emissions free and while IHC Merwede plans to construct many such

sustainable vessels, at this time the equipment is not available for general use (IHC Merwede 2010).

There are more examples of ancillary equipment to dredging and capping that have emission reduction technologies. Foss Maritime partnered with the Port of Long Beach and released a diesel-electric hybrid tug in 2009. This equipment is marketed as both environmentally friendly and equally powerful and maneuverable in comparison to conventional tugboats. Exhaust abatement technology for pilot boats and barges is also available. Hug Engineering's Emission Control Systems was recently used on Dutch pilot boats. While these boats were destined for Europe, they were manufactured by Kvichak Marine in Seattle (Hug Engineering 2010).

Federal emissions standards for non-road engines follow a four-tiered approach that has been gradually implemented since 1996. Tier 1 to 3 standards, which relied on advanced engine design rather than engine retrofits, were phased in consecutively from 1996 through 2008. Tier 4/Stage IIIB standards are currently being phased in; these regulations require a 90 percent reduction in PM and a 50 percent reduction in NO<sub>x</sub> from the Tier 3 requirement. Tier 4/Stage IV standards will be implemented in 2015; this will require an additional 80 percent decrease in NO<sub>x</sub> emissions from the Tier 4/Stage III requirement (DieselNet 2011).

Specific examples of standard diesel exhaust retrofit devices that may reduce emissions include:

- Diesel oxidation catalyst, a device that oxidizes gaseous hydrocarbons, CO, and some PM.
- Diesel PM filter, which collects PM and oxidizes it.
- Partial diesel particulate filter that is a combination of the above. Benefits of this device include less pressure drop than a diesel PM filter and more efficient particle oxidation than a diesel oxidation catalyst.
- Selective catalytic reduction technology, which reduces NO<sub>x</sub> emissions.
- Closed crankcase ventilation, which captures the oil in emitted gas, returns it into the crankcase, and then directs it back to the intake system for combustion rather than emission into the air.
- Exhaust gas recirculation, which recirculates exhaust gas, reducing NO<sub>x</sub> emissions.
- Lean Nox catalyst, which uses diesel fuel injected into exhaust to create a reaction that reduces pollution. This technology may be paired with diesel PM filters or diesel oxidation catalysts. While pollutants may be reduced, overall fuel usage increases by 5 to 7 percent.

If we assumed that the emissions analysis presented in draft FS Appendix Ic is based upon Tier 3 engines, the implementation of Tier 4/Stage III and IV requirements may

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equate to a 90 percent reduction in both PM and NO<sub>x</sub>. Options within the Portland area for meeting these requirements include engine retrofits with products described above, renting or purchasing compliant machines, and/or having machines rebuilt to meet these standards.

### 6.3.2 Green Practice Opportunities

Emissions associated with the proposed cleanup alternatives may be significantly reduced through the application of green remediation BMPs promoting reduction and efficiency of fuel consumption and the use of alternative fuels to power equipment and facilitate transportation. These BMPs are closely related to BMPs applied to conservation of energy, because the release of emissions is closely tied to the amount and type of fuel consumed. The following BMPs may be applied to the proposed alternatives as practicable to achieve green remediation goals:

- To address the findings of draft FS Appendix Ic, Section 4.1 that transporting materials for capping may contribute to significant emissions, local sourcing (less than 100 miles from Site) of capping materials can be maximized.
- To address the conclusions of Appendix Ic, Section 4.2 that transport to upland disposal options significantly impacts emissions, in-water CDF or CAD disposal can be maximized and transport of materials outside of the local area can be minimized.
- For any necessary transport outside the local area, train transport may be favored over transport by barge or truck. Transport by barge may be minimized by using within Site transload facilities, which allow transfer to trains.
- Dredging activities should be carefully monitored to ensure that unintentional overdredging, and thus increased dredge volumes, are minimized.
- Emissions should be monitored and tracked, and operations and maintenance plans to reduce emissions should be developed.
- Treatment processes should be routinely evaluated for optimal performance and optimization; this could potentially lead to possible equipment downsizing or shutoff.
- Local services and materials may be used to shorten transportation routes.
- Work should be scheduled and sequenced to minimize travel and double handling of materials.
- Routine maintenance, inspections, and repairs of industrial equipment should be conducted.
- An idle reduction plan for construction equipment should be implemented.
- Free product or emissions may be captured for on-site energy recovery.
- Alternative fuels may be used.

- Stockpiles should be covered with tarps or other dust control measures should be applied to reduce dust from stockpiles.
- Construction equipment with enhanced emissions controls that meet Tier 4 standards may be used.

## 6.4 WATER USE AND IMPACTS TO WATER RESOURCES

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### Rationale for Remedial Technologies Ranking

Evaluating the potential impacts of various alternatives to water resources is discussed in Section 8.0 of the draft FS main text both in terms of short- and long-term water quality issues. These issues are further discussed in draft FS Appendix Ia (dredging water quality), Appendix Jb (CDF short- and long-term water quality), Appendices Ha and Hc (long-term water quality combined alternatives and capping). An overview of water quality minimization practices and compliance with the Clean Water Act (CWA) is provided in the draft FS Appendix M 404(b)(1) analysis.

In general, the remedial technologies with the greatest environmental footprint related to water quality and use are those with the longest active construction durations, particularly those that involve more dredging. Thus, dredging has the greatest water quality impacts; although in-place options such as capping and in situ treatment have some low-level effects on water quality. Construction of on-Site disposal CDF and CADs will create some water quality impacts during berm and facility construction, but no water quality impacts are expected during facility filling because of the most likely methods to be used in filling discussed in Appendix Jb. Also, sediment dewatering processes assumed for draft FS purposes (addition of drying agents) is not expected to result in much if any dewater discharge back to the Lower Willamette River. If this did occur, the water would be treated before discharge. Thus, upland disposal is expected to have slightly less impact on water quality than on-Site disposal. While MNR and EMNR technologies will involve some in-water sampling and fill placement (EMNR), these have the lowest water quality impacts in relation to the other remedial technologies.

Water use is relatively minimal for most remedial technologies. The most likely water use would be dust suppression and other minor water uses at transload facilities and upland landfills.

### Rationale for Green Opportunity Ranking

The opportunities for green remediation for the water core element are dissimilar to the energy and emissions elements in that the technologies that have the greatest water environmental footprint are not the technologies with the greatest green opportunities. This is because the use of these technologies (e.g., dredging) already assumes that BMPs to reduce water quality impacts will be applied to the extent practicable. Therefore, for this core element, the greatest opportunities for reduction of impacts relate to the reduction of the relatively minor potable water use. As such, the remedial technology with the greatest opportunity to reduce water use is upland disposal. Potable water use in

dust control can likely be reduced through maintaining sediments in a dewatered, but still moist, state.

#### 6.4.1 Green Practice Opportunities

A priority of DEQ and the City of Portland is to protect water resources in part by encouraging water reuse. Options include harvesting rainwater or using water from on or off-Site that has been reclaimed or recycled.

Rainwater harvesting is encouraged by the City of Portland for outdoor activities such as irrigation. Indoor non-drinking use is also allowed if City code parameters are applied. A permit is not required for rainwater harvesting systems that are less than 5,000 gallons and have a height to width ratio of under 2:1 (Portland Water Bureau 2011).

DEQ classifies the different types of treated wastewater as follows:

- Gray water refers to shower, bath, sink, and laundry wastewater. This category does not apply to toilet, garbage, or wastewater contaminated by soiled diapers. Gray water may be treated or untreated.
- Recycled water is treated effluent from wastewater treatment plants that can be used for various non-drinking purposes depending on the level of treatment undergone.
- Industrial wastewater refers to the treated effluent from industrial processes or from the development or recovery of natural resources.

Strategies and requirements that allow for water reuse while protecting public health and the environment are described in detail in DEQ's Water Reuse Program website (<http://www.deq.state.or.us/wq/reuse/reuse.htm>). A review of state regulations for wastewater reuse is also provided by EPA (<http://www.epa.gov/NRMRL/pubs/625r04108/625r04108.htm>). For restricted urban reuse, which includes landscapes without frequent public access, level two biological treatment and disinfection is required with total coliform samples of 240/100 mL (two consecutive samples) and 23/100 mL (7-day median).

Specific potable water use reduction BMPs for sediment remediation alternatives, as practicable, may include:

- Using drainage water from the CDF
- Using CDF water for pumping of sediments from barges into the CDF (see draft FS Appendix Ja)
- Using treated dewater (for passive or active dewatering technologies that do not result in adsorption of water with the sediment)

- Exploring the use of gray water and/or capturing rainwater for on-Site tasks such as irrigation, dust control, concrete production, fire protection, toilet/urinal flushing, and wheel wash water (EPA 2004)
- Using closed-loop gray water systems to wash machinery and equipment
- Using tarps and mats to cover un-vegetated soils, rather than using water to suppress dust
- Using vacuum rather than water street sweepers
- Using low-flow sampling equipment when possible during monitoring
- Using low-water use options for irrigation such as drip irrigation, evapotranspiration (ET) controllers, scheduling irrigation using non-ET controllers during early or late hours, and providing regular maintenance and adjustment of irrigation controllers.

#### 6.4.2 Technical and Financial Assistance

The City of Portland administers an internationally acclaimed stormwater management program that can provide technical assistance (<http://www.portlandonline.com/bes/index.cfm?c=34598>). Further technical guidance can be provided through the Center for Watershed Protection's Stormwater Center (<http://cwp.org/our-work/services.html>). To address non-point sources of pollution within surface and ground water systems, DEQ administers the "319" federal grants for government, tribe, and nonprofit proposals.

### 6.5 WASTE

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#### Rationale for Remedial Technologies Ranking

The waste reduction core element of green remediation considers the lifecycle costs that are inherent for all products and materials used for the remedial action. This core element may be easier to implement than the others because beneficial reuse of materials is already a common practice in construction. Overall, the benefits of waste reduction may include:

- Reducing the use of landfills for disposal
- Reducing the environmental impact of production and disposal of materials
- Reducing the overall project cost

The largest source of waste from the proposed action will be dredged sediment. Another potentially large source of waste is overwater structure removal. Unlike dredged sediments, these structures have a much higher opportunity for reuse to reduce landfill disposal. The smallest waste generating technologies include MNR, EMNR, in situ treatment, and capping. While residual waste from construction and monitoring activities will occur with these technologies, the waste generated will be minimal in comparison to dredging activities. The beneficial reuse of sediments either before or after treatment was

also investigated for the project (Anchor QEA 2009a and 2009b; and EPA 2009a). Although the draft FS alternatives do not include any ex situ treatment other than dewatering, several other types of ex situ treatment of sediments were screened through in Section 6.2 of the draft FS for possible use in SMA-specific remedial designs. If these technologies are used, there may be opportunities for beneficial uses of treated materials, which are discussed in more detail in Anchor QEA (2009a).

### **Rationale for Green Opportunity Ranking**

The most significant way to reduce waste production is through use of in-place remediation technologies (i.e., EMNR, capping, and in situ treatment) over removal. Once sediment is removed (i.e., ex situ), sediment treatment technologies discussed in Section 6.2 of the draft FS could be employed to treat contamination and allow for some sediment reuses or reduction in disposed volumes in some cases. A subset of these technologies is recommended to be retained for further evaluation and potential use in some SMA-specific remedial designs (see draft FS Section 6.2). The major impediment to widespread use of the select ex situ treatment technologies retained for remedial design is that they are energy intensive and/or have other effectiveness or implementability issues. Thus, while these technologies may reduce disposed waste in many cases, this may be accomplished at the expense of much higher energy expenditure and attendant GHG emissions. Given this constraint, the primary way to reduce disposed volumes as part of removal technologies is to maximize the ability to segregate clean sediment from contaminated sediment through detailed characterization in remedial design of sediments to be removed and careful dredging practices and confirmatory monitoring to minimize the amount of relatively clean material removed and disposed. As noted above, in-place remedial technologies avoid this waste generation entirely, and may be superior to removal based technologies in this regard.

Capping and EMNR provide an opportunity to beneficially use material from a separate off-Site activity (such as clean maintenance dredging spoils) to reduce the amount of waste from this separate activity. Overwater structures removed during construction activities may also provide an opportunity for beneficial reuse, if a suitable recycler is found for these materials.

#### **6.5.1 Green Technology Opportunities**

Technologies for waste reduction include equipment that provides waste size reduction, such as compactors and bailers, and equipment that can provide a recycled product for reuse, such as shredders, chippers, and grinders.

#### **6.5.2 Green Practice Opportunities**

Waste planning should be included within the Site Management Plan. This section should include requirements, as practicable, related to purchasing and disposal during demolition, construction, and all other support activities during the remedial action (EPA 2008a).

- Prior to active remediation activities, develop a waste management and reduction plan that highlights specific areas on-Site that can be used to sort and store waste materials. Multiple areas may be required to avoid cross contamination. Identify potential recyclers for specific waste materials.
- Coordinate with local recycling programs and recycling businesses to make sure that the waste management plan conforms with all requirements and to understand logistics of access, cost, and other needs by agency/recycled materials handlers.
- Provide composting and recycling receptacles on-Site.
- Identify opportunities for salvage and material reuse that is consistent with remediation goals and requirements. Salvage all marketable recoverable materials such as metals, wood, and rock for reuse.
- Given that the most significant waste volumes will come from dredge sediments, dredging activities should be carefully monitored to ensure that unintentional overdredging, and thus increased waste materials, are minimized.
- Salvage wood from dock and piling removal for reuse. An evaluation of reused creosote piling showed that re-sawing piles into 12 by 12-inch timbers produced high quality wales and chocks for a naval facility, and the process was economically feasible with a savings of \$32/ton (Sheldon et al. 2001). Wood decking may be replaned or simply flipped over to be reused as decking on or off-Site. A few guidelines for reusing treated wood include:
  - Avoid reuse of treated wood where it will come in direct or indirect contact with drinking water for people or animals; however, incidental contact (e.g., at docks) is acceptable under federal guidelines.
  - Avoid reuse in areas that will come in contact with food for people or animals or beehives.
  - Avoid reuse within homes, decks, and playgrounds
  - When power-sawing wear eye protection and wash exposed areas around the work area and from work clothing to remove particles  
(<http://www.ct.gov/dep/cwp/view.asp?a=2714&q=324870>).
- If possible, use existing buildings on-Site for storage and management of monitoring equipment.
- Reuse trees that require removal as habitat snags, in-water large woody debris, or grind un-treated waste wood and other materials for on-Site or off-Site use. Other land-clearing debris such as shrubs and groundcovers may be composted.
- With minimal processing concrete may be reused onsite in upland areas for bulk fill, bank protection, drainage structure bases or fills, road construction and embankments for noise control. With additional processing this material may be used in new concrete applications including structural-grade concrete, soil-cement

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pavement bases, lean-concrete bases and bituminous concrete ([http://www.cement.org/tech/cct\\_aggregates\\_recycled.asp](http://www.cement.org/tech/cct_aggregates_recycled.asp)).

- Salvage and recycle metal and provide both environmental and substantial economic benefits to the project. Resources for locating a construction steel and iron recycler is provided through the Steel Recycling Institute: <http://www.recycle-steel.org/Recycling%20Resources/Locator.aspx>
- Identify potential partnering projects that may produce materials that would otherwise be disposed of as waste material, for example, beneficial reuse of maintenance dredging materials for capping or other fill material.
- Incorporate green requirements into procurement standards, such as specifying the use of products that contain a set percentage of recycled material. Include environmentally preferred language for products within specifications.
- For administrative tasks, encourage the use of electronic resources for documents and meetings (phone or internet-based) to reduce paper-based communications and waste.
- Preferentially specify imported materials that are from recycled versus virgin sources, such as stone or glass for aggregates and paving materials, and steel, concrete, and plastic/composite materials for dock pilings and decking. Specify fly ash for use in concrete mixes.
- Choose products with packing material that can be reused or recycled.
- Crush existing structures to optimize scrap recovery and produce fill materials
- Grind waste wood and other materials for on-Site use, or reuse as fuel or mulch.

### 6.5.3 Technical and Financial Assistance

DEQ provides the Commercial Waste Reduction Clearinghouse that provides technical information on waste reduction strategies and links to recycling and waste reduction networks. Oregon Metro also provides a construction salvage and recycling resource including a directory of more than 100 local recycling sites. Also, the NW Materialsmart and Boneyard NW both provide links to various material exchange opportunities in Oregon and Washington.

DEQ administers grants to local governments for solid waste reduction and recycling programs. These grants must be paid to local governments; however, partnerships between governments and private businesses and community groups are allowed. The EPA Region 10 Waste Division also provides grants for waste reduction/recycling programs.

## 6.6 LAND AND ECOSYSTEMS

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### Rationale for Remedial Technologies Ranking

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The draft FS considers alternatives designed to address impacted sediments at the Site below the +13 foot NAVD88 elevation. An exception is the creation of a CDF that would extend above this elevation. As a result, most of the potential land and ecosystem impacts of the draft FS alternatives are aquatic impacts, specifically impacts to Essential Fish habitat (EFH) including shoreline habitat used by salmonids, benthic habitat, and overall water quality. A detailed discussion of the impacts and potential mitigation and conservation measures to affected essential fish habitat (EFH) is included in the Preliminary Draft Site-Wide Biological Assessment (BA) submitted under separate cover with the draft FS and summarized in Table 5 of the same document.

As discussed in the previous sections, potential impacts are transferred off-Site via energy and material consumption, release of GHGs, and waste generation affecting other land and ecosystems beyond the primary impact site as described in Sections 6.2 through 6.5. Generally, EMNR and in situ treatment would have the least potential off-Site impact, while dredging, capping, and the associated disposal and structure installation and removal have a greater potential to affect off-Site land and ecosystems beyond the above described impacts to the aquatic environment on Site.

The remedial technologies with the greatest environmental footprints related to land and ecosystems on-Site are those that reduce the quantity and quality of shallow water habitat, i.e. Alternatives E and F. Dredging within the active channel margin would displace valuable habitat by converting shallow water habitat to deep water. Placement of capping armor (riprap) over sand/gravel substrate in active channel margin or in other shallow water zones may degrade habitat by displacing suitable substrate. Construction of a CDF for the placement of dredged materials may result in a conversion of nearshore habitat to upland, displacing aquatic habitat. The potential habitat impacts and estimation of likely mitigation requirements for those impacts are presented in Appendix M of the draft FS (as well as the Preliminary Draft BA).

### **Rationale for Green Opportunity Ranking**

The protection of ecosystem services is another important aspect of green remediation. Ecosystems have physical, biological, and chemical elements that facilitate the transfer and storage of materials and energy through the environment.

This land and ecosystems core element involves minimizing degradation and/or enhancing the ecology of the Site and other affected areas. BMPs provide tools for preserving existing wildlife habitat during remediation and accelerating the beneficial reuse of previously degraded land to enhance biodiversity following remediation actions.

The proposed remedial action will occur in the downstream reach of the Lower Willamette River with the potential for mitigation actions to occur within a portion of the Lower Columbia River. The Site has been extensively modified by wetland draining, channelization, and dredging for creation and maintenance of the navigation channel and ship berthing areas (Integral et al 2011). Approximately 79 percent of the pre-industrial era shallow water through the Lower Willamette River no longer exists due to historical

channel deepening (Northwest Power and Conservation Council 2004). The Lower Columbia River estuary has approximately 43 percent less tidal marsh and 77 percent less tidal swamp habitats compared to historical conditions of 1870 (Thomas 1983).

Given the degraded condition of the Site's natural habitats, there are opportunities to restore ecosystem services through creation of active channel margin, nearshore shallow water, and riparian habitats and to conserve and enhance the limited habitat that is currently present.

Several locations have been identified for habitat restoration within the Site, and the LWG has evaluated the potential for remediation under each alternative to be incorporated into these identified restoration sites. This is consistent with the project Management Goal #3 described in draft FS Section 3.3, which is, "clean up contaminated sediments in a manner that promotes habitat that will support a healthy aquatic ecosystem and the conservation and recovery of threatened and endangered species."

Long-term monitoring associated with MNR and EMNR provides one of the greatest opportunities for ecosystem protection. EMNR also involves limited sediment placement which, if properly sized, could provide habitat benefit to aquatic species, especially since the existing substrate on Site is generally degraded. The same opportunity exists when placing an engineered cap. Placement of suitable sediment for capping could benefit aquatic habitat. In addition, mitigation efforts considered as part of the project could also lead to further aquatic and/or terrestrial restoration.

The following sections discuss methods to minimize potential degradation of the aquatic ecosystem and enhancing the suite of ecosystem services or specific aquatic ecosystem functions provided by the Site.

#### **6.6.1.1 Habitat Preservation Opportunities**

An initial step towards preserving ecosystem services within a site involves performing a detailed baseline inventory, including photographic documentation of plant and animal species, topography, and drainage patterns. This would likely be done in remedial design of each SMA. An FS-level assessment of baseline aquatic conditions has occurred for the purposes of assessing potential impacts of the remedial alternatives for the Preliminary Draft BA and for the CWA Section 404(b)(1) analysis (draft FS Appendix M) to the upland extent of the current Site boundary at +13 feet NAVD88. For the purposes of the final SMA-specific remedial design, this survey of baseline conditions may be augmented for adjacent riparian zone and terrestrial shoreline areas above the current project elevation, as well as additional SMA-specific aquatic information to complete the remedial design. The baseline condition assessment is compared to the "proposed" conditions (i.e., condition of the system after remediation) in order to determine the potential impact of the remedial action on various ecosystem services. For the purposes of the CWA Section 404(b)(1) analysis, this comparison was conducted to determine the potential impact of the remedial alternatives on a set of ecosystem services (or ecosystem functions) provided for aquatic species (see draft FS Appendix M, Section 1 for further details).

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This document is currently under review by US EPA and its federal, state, and tribal partners, and is subject to change in whole or in part.

### 6.6.1.2 Aquatic Ecosystem Enhancement Opportunities

As detailed in the Preliminary Draft BA and draft FS Appendix M, while the majority of the Lower Willamette River shorelines have been heavily modified to support industrial development and use, the Portland Harbor Site currently supports rearing and connectivity (migration/movement) functions for salmonids and other aquatic species and supports various life history stages for other aquatic-dependent birds (such as osprey) and mammals (such as mink) that rely upon salmon and aquatic species as a large component of their prey base (Anchor QEA 2011). The proposed project activities such as dredging, in-place remediation, construction of a CAD or CDF, and construction of CWA 404(b)(1) mitigation may result in aquatic habitat conversions and disturbance of substrates and associated benthic communities that serve as prey for listed species, including salmon.

The proposed cleanup will improve overall sediment and water quality. Aquatic habitat may be negatively affected by a change in dominant substrate type as a result of in situ capping resulting in placement of large rock. However, remediation activities could also improve substrate (and thus salmon prey production conditions) in areas with existing debris or silt-dominated substrates by placing sand/gravel substrate as the final surface material. Sand/gravel substrates may produce more complex benthic communities than silt dominated substrates and, therefore, better forage conditions<sup>3</sup>.

#### 6.6.1.2.1 Aquatic Habitat BMPs

Green remediation approaches include strategies for accelerated ecological land reuse of degraded sites including habitat preservation and restoration. In support of this approach and consistent with Management Goal #3, LWG evaluated the potential impact of the various remedial alternatives on sites within Portland Harbor that have been identified as potentially suitable for habitat preservation and/or restoration. Generally, habitat restoration and/or preservation may be less compatible with remedial technologies that include the use of engineered caps with large anchor rock (i.e., riprap) that is in the nearshore or active channel margin due to the low function riprap provides in terms of supporting benthic communities as well as rearing habitat for juvenile fish.

Any remedial action that involves discharge of material into the Lower Willamette River must demonstrate substantive compliance with the CWA Section 404(b)(1). Under these regulations, potential impacts to the aquatic environment must first be avoided and then minimized to the extent practicable. Several BMPs addressing avoidance and minimization measures that may be considered as part of the remedial alternatives are discussed in detail in draft FS Appendix M, Section 13. In addition, the following BMPs

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<sup>3</sup> Substrate quality and quantity play an important role in the development of a healthy benthic community and benthic forage base for listed salmonids. Simpson et al 1986 and Bournaud 1998 sampled benthic invertebrates from various freshwater locations in two separate studies. The richness of benthic invertebrates at the sampling stations was generally correlated with substrate type. Heterogeneous substrates (sands mixed with silts) contained the richest fauna. The fewest taxa occurred in fine, well sorted sand. In silty-clay substrates, the presence of at least some sand was necessary for the occurrence of several taxa and the abundance of others. Substrate type (cobble, gravel, sand) did have an effect on the composition of species; however, it is difficult to tell how much of an effect (Bournaud 1998).

identified in EPA's green remediation guidance (EPA 2008a) may further contribute to the preservation of aquatic habitat and its function as part of a remedial action:

- Develop guidelines for daily operations that minimize wildlife disturbances, such as noise and light.
- Use minimal invasive in situ technologies.
- Use passive energy technologies, such as on-Site generated solar or wind energy, as remedies where possible and effective.
- Minimize habitat disturbance.
- Create Site management plan to describe ecological preservation approach for anticipated reuse of the cleanup Site.
- Improve substrate conditions where existing conditions are degraded by human activities. Provide substrates that support higher benthic productivity that supports salmon and other aquatic and aquatic-dependent species.

#### **6.6.1.3 Aquatic Habitat Mitigation Considerations/Opportunities**

Aquatic species in the Lower Willamette River, including Endangered Species Act (ESA)-listed salmon, have diverse habitat requirements to support their survival, growth, and reproduction. Given the importance of salmonids to the region, mitigation that promotes successful rearing and migration functions is recommended. Although these functions are most directly related to salmon, they may also support other aquatic species that occupy similar habitats within the Lower Willamette and are important in the region for conservation purposes (City of Portland 2009).

Juvenile salmon rely on specific habitat features to avoid predation, to forage, and to successfully compete for resources. For adults, the same habitat elements allow predator avoidance and provide low-energy waters allowing salmon to swim upstream towards spawning on limited energy stores. Potential aquatic habitat mitigation components for Site locations potentially impacted by the remedial alternatives may include creation of off-channel habitat, and shallow water/active channel margin habitat including placement of sand/gravel substrates, creation of shoreline complexity (shallow slopes with large woody debris [LWD] structures and overhanging vegetation), and adjacent riparian areas (Anchor QEA 2011). The following sections detail specific restoration components to consider in the preservation of ecosystem services and functions in Portland Harbor.

##### **6.6.1.3.1 Water Depth and Shoreline Complexity Component**

Creating and enhancing aquatic habitat in the active channel margin between the ordinary low water (OLW) and the ordinary high water (OHW) elevations and nearshore shallow water areas as proposed as part of the CWA 404(b)(1) mitigation project are important components for creating successful juvenile salmon habitat.

Emphasis should be placed on the creation or enhancement of aquatic habitat in the upper elevations (+13 to 5.1 feet NAVD88 and 5.1 to -4.9 feet NAVD 88), due to the extensive shoreline and channel modifications that have resulted in minimal shallow water habitat

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and overly steepened and hardened banks. This water depth elevation zone is seasonally (i.e., at high water in winter and spring) available to fish and aquatic species and provides important functions related to the growth and survival of juvenile salmonid species and lamprey ammocoetes. More information about the importance of different water depth elevations for species in the Lower Willamette River can be found in draft FS Appendix M, Attachment 1.

Shallow slopes are preferable because shallow-sloped beaches and shallow water areas are known to attract juvenile salmon. The most juvenile salmon were observed in areas with a 10 percent maximum slope, and declined significantly when slopes exceeded 30 percent. Shallow sloped shorelines combined with elements such as embayments and features such as LWD may create and restore habitat complexity that is currently missing from much of the lower river system. LWD, including logs and/or trees with rootwads or branches, may be placed in shallow water areas. LWD must be large enough to be retained on the shoreline. Suitability for placement of LWD would be determined at the time of SMA-specific remedial design.

#### **6.6.1.3.2 Substrates and Other Habitat Features**

Suitable substrates for aquatic habitat in the Lower Willamette River may consist of sand/gravel mixes. Generally, substrates should be sized based on hydrodynamic energy exposure levels to ensure relative stability of the material placed and to provide suitable habitat for benthic production thereby possibly increasing forage availability for salmon and other aquatic species. Substrates may include pea gravels, sand, and rounded gravels ranging in size from 1½-inch minus to 2-inch minus.

Other aquatic habitat features may include creation of emergent marsh habitat and riparian vegetation restoration in the upland along the shoreline, which may benefit aquatic habitat by shading and detritus input.

#### **6.6.1.4 Technical and Financial Assistance**

As part of the CWA Section 404(b)(1) compensatory mitigation hierarchy, mitigation banking instruments and in lieu fee programs are preferable to projects conducted by the regulated entity. Both the Oregon Department of State Lands and the Portland District of the USACE track the development of mitigation banks by watershed throughout Oregon. If such instruments are unavailable, identification of potential mitigation sites or suitable mitigation plans may be assisted through coordination with one of several groups organized for the purposes of restoring wetland, riparian, and riverine habitat in the Lower Willamette River watershed as well as the Lower Columbia River Watershed. The Governor's Oregon Watershed Enhancement Board (OWEB) provides technical and financial assistance for projects that improve riparian habitat, river, lake, stream, and wetland habitat restoration and conservation. While the project would not be eligible for financial assistance, it may benefit from technical assistance that is provided through this program.

## 7.0 ALTERNATIVES EVALUATION

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### 7.1 EVALUATION OF ALTERNATIVES AS PRESENTED IN DRAFT FS

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First and foremost, the objective of green remediation is to achieve the RAOs, and the alternative selection process is not driven by green remediation considerations; rather, the green remediation principles are intended to reduce the environmental footprint of the selected alternative. The evaluation of the alternatives for the purpose of this document includes ranking their environmental footprint by evaluating the remedial technologies that comprise the alternatives as described in Section 6.0 of this appendix. Opportunities to reduce the environmental footprint by incorporation of green remediation principles were also assessed in Section 6.0. Full assessment of the feasibility of implementing various green opportunities will require further evaluation during remedial design.

The remedial alternatives for the Site have been evaluated in detail within Section 8.0 of the draft FS. Since the discussion of green remediation elements has been tied to specific remedial technologies, and each alternative is composed of a variety of remedial technologies, Table 7-1 illustrates each alternative based on the proportion of remedial technologies employed. This breakdown is based on the percentage by area of each technology and the percentage of disposal options by volume. To take into account the total disposal quantity as well as the disposal locations, the percentage of disposal volumes is shown relative to the largest disposal quantity of Alternative F-r.

Table 7-2 ranks the environmental footprint of each alternative assuming conventional remedial technology actions. This table begins with applying the quantified score (-1, 0 or +1) to each remedial technology ranking in Table 6-1. These scores are added together to produce a footprint score for each remedial technology. This score is multiplied by the percentages provided in Table 7-1 producing a score for each alternative; these are then ranked in order, with a ranking of “1” indicating the lowest environmental footprint. This analysis does not use footprint calculation procedures recently released from EPA (EPA 2011d). This newer EPA guidance for environmental footprint analysis may be used in later review cycles of this document.

Overall, MNR has the smallest environmental footprint of any individual remedial technology, and all of the alternatives use of MNR for the majority of the Site. However, the amount of MNR in each alternative is an important factor in determining the relative size of its environmental footprint. In addition to the proportion of MNR, those alternatives with the greater extent of dredging, associated upland disposal, and engineered capping, have the highest environmental footprints.

### 7.2 EVALUATION OF ALTERNATIVES BY APPLICATION OF GREEN TECHNOLOGIES AND PRACTICES

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Each alternative varies not only by the size of its footprint, but also by its potential to incorporate green remediation technologies and practices. Opportunities for implementing green remediation technologies and practices depend on the scope and type

of activities associated with any given alternative, as well as the availability and proximity of alternative energy and material sources.

Table 7-3 summarizes opportunities for environmental footprint reduction through the application of green technologies and practices associated with the five core elements of green remediation for each alternative. Using a similar methodology to Table 7-2, this evaluation reflects a qualitative ranking of the opportunities for footprint reductions to remedial technologies as shown in Table 6-1. These rankings are multiplied by quantitative information provided in Table 7-1 related to size in area and reverse-normalized volume, as greater volumes for disposal are assumed to correlate with greater green remediation opportunities. A ranking of “1” indicates the alternative with the highest opportunities for implementing green remediation technologies and practices. This assessment is intended to show the environmental footprint reduction potential of each alternative.

Overall, the greatest opportunities for implementing green remediation practices can be found in the alternatives that include the greatest amounts of dredging, upland disposal, and generally greater amounts of capping.

### 7.3 SUMMARY EVALUATION

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Table 7-4 provides a summary of the overall environmental footprint of each alternative based on a combination of the inherent footprint of these alternatives, plus the application of green remediation technologies and practices. The table was produced by adding together the total scores by alternative from Tables 7-2 and 7-3.

By comparing the inherent environmental footprint rankings in Table 7-2 with varying percentages of green opportunities applied in Table 7-3 it becomes clear that the degree of implementation of green opportunities can moderately influence the overall environmental footprint of each alternative. If 100 percent of green opportunities are assumed, the greenest alternative is Alternative C-r, which has relatively high amounts of MNR, does not use in situ treatment, has relatively low amounts of dredging and capping, and has a substantial volume placed in on-Site CDFs rather than upland disposal. The alternative that is least green in this analysis is Alternative F-r, which contains significant amounts of dredging, capping, and a majority of the dredge material volume goes to upland disposal. The 50 percent and 25 percent green remediation columns produce identical results to Table 7-2. In these two scenarios, Alternative C-r drops to the fifth rank and Alternative B-i becomes the greenest ranked option. This is due to Alternative B-i’s high emphasis on MNR resulting in relatively low amounts of dredging and capping as well as the lowest total disposal volumes of all of the alternatives.

## 8.0 STEWARDSHIP

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Environmental stewardship is at the core of the green remediation strategy affecting all phases and aspects of the project, including long-term monitoring and maintenance, and future reuse of the Site, as well as continuing community involvement and public outreach. Community involvement is an important core component of EPA's Superfund program and, therefore, an integral part of the green remediation strategy.

### 8.1 COMMUNITY INVOLVEMENT/EDUCATION

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The public's role as a stakeholder in the remedial process has expanded over time, specifically in participation in sustainability-focused discussions regarding the remedy's impact on community livability and vitality, reuse of the remediated area, and residual environmental impacts (SURF 2009). Various guidance and policy documents address community involvement as one of the main principles of green remediation. They define the goal of facilitating community involvement as follows:

- Increase public acceptance and awareness of long-term activities and restrictions (EPA 2008a)
- Encourage communities to carefully assess and consider lifecycle implications associated with future use and adopt more sustainable approach to land use, building and infrastructure design and construction, community health and livability, and resource conservation and protection (EPA 2009e).

Other guidance documents identify educational opportunities related to environmental stewardship and sustainable activities as a benefit resulting from the integration of green remediation principles. All of the practices and tools detailed below are equally applicable to all alternatives.

#### 8.1.1 Practices and Tools

A variety of community outreach tools may be utilized:

- Online site resources made available to access current Site information
- Fact sheets to provide citizens with easy-to-understand information regarding the cleanup
- Public/stakeholder meetings to provide updates on Site developments and address community questions
- Maintain mailing list to facilitate information distribution to interested parties
- Project Site visits and tours, if feasible, to enhance community's understanding of Site cleanup and activities, as well as Site access and use restrictions

#### 8.1.2 LWG Public Process

The LWG recognized the importance of engaging the public early on in the process to encourage open and transparent communication about the Site. The Portland Harbor

Community Advisory Group (CAG) has spent considerable time discussing issues related to green remediation and sustainability considerations<sup>4</sup>. These discussions pre-dated OSWER guidance and Region 10's Clean and Green guidelines quoted above. As early as 2004 and 2005, the CAG was commenting on the need for more sustainable practices. LWG took note of these comments and specifically addressed them in subsequent presentations.

The following summarizes some of the comments provided by the CAG over the past nine years:

- The main themes of sustainability have been: the use of BMPs for remedial design and construction; the encouragement of innovative technologies that can treat sediment in situ or nearby to avoid lengthy transportation of dredge materials; and the use of renewable energy for remediation activities. Some level of in situ treatment is included in every draft FS alternative.
- The April 13, 2010 CAG meeting was devoted specifically to discussing possible BMPs with dredging; how to best define "green remediation"; passive source control measures, such as bioswales to encourage natural recovery without invasive carbon-producing remediation; and land use zoning and management to mitigate upland contamination. The use of biofuels for construction equipment was also encouraged at this meeting. Many of these issues and their role in the alternatives are discussed above.
- The July 14, 2010 CAG meeting explored more innovative opportunities for in situ treatment, including active carbon and nearshore treatment facilities that would wash or treat sediment for beneficial reuse. Some level of in situ treatment is included in every draft FS alternative. As noted above, ex situ treatment beyond de-watering is not incorporated into any of the draft FS alternatives, but some ex situ treatment technologies were retained for some SMAs for further consideration in remedial design, for reasons noted previously.
- In October 2010, EPA led the CAG through a planning session for public outreach planning for the draft FS. At that meeting several comments were made about wanting to see the use of sustainable practices, including using as much local labor as possible to keep jobs in the community.

The LWG public involvement activities focused on green remediation principles to be applied to project activities, as practicable, in order to reduce the environmental footprint of the selected remedy in accordance with the current EPA policies pertaining to green remediation. Requests by the community for sustainable practices, such as using local labor, will likely be considered during remedial design, but extend beyond the scope of green remediation, into the social aspects of sustainability.

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<sup>4</sup> The focus of this document is on green remediation technologies and practices as defined by the EPA, addressing reduction of energy and water consumption and emission of air pollutants and GHGs, and general conservation of resources (EPA 2010a and EPA 2008a); see Section 3.1.1.

## **8.2 LONG-TERM MONITORING AND MAINTENANCE, AND FUTURE REUSE**

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Long-term opportunities to apply green remediation principles are associated with long-term monitoring and maintenance and future reuse of the Site. These opportunities are not limited to reducing the environmental footprint of activities, but can also improve upon traditional techniques, as in the case of using passive sampling devices for long-term monitoring of sediment, groundwater, and surface water quality. These methods provide for steady data collection at less cost while generating less waste (EPA 2008a). Other long-term stewardship actions, as practicable, may include:

- Installation of renewable energy systems to power long-term cleanup and future activities on redeveloped Site.
- Application of general green remediation technologies and practices as detailed in Section 5.0.
- Reduction of CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub> and GHGs emissions potentially contributing to climate change.
- Reducing field travel by using remote monitoring system to monitor effectiveness of treatment systems.
- Incorporating operation and maintenance plans that minimize wildlife disturbance and protect natural resources into final reuse plan.
- Integrating the remedy with the anticipated Site end or future use, where possible.

## 9.0 REFERENCES

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- Anderson, M.J. and Barkdoll, B.D. 2010. Journal of Waterway, Port, Coastal, and Ocean Engineering. 136 (4): 191-199.
- Anchor QEA. 2009a. Treatment Beneficial Use Market Survey, Portland Harbor RI/FS. Prepared for LWG. A09-02. Portland, OR.
- Anchor QEA. 2009b. Lower Willamette Group July 23, 2009 Responses to EPA's June 17, 2009 Comments on the Draft Treatment Beneficial Use Market Survey. Portland, OR.
- Anchor QEA. 2011. Habitat Framework. Prepared for the Willamette Group. Portland, OR.
- Anchor QEA. 2012. Preliminary Draft Site-Wide Biological Assessment. Prepared for the Willamette Group. November 2011. Portland, OR.
- Bournaud M, Tachet H, Berly A, Cellot B. 1998. Importance of microhabitat characteristics in the macrobenthos of a large river reach. Annals of Limnology 31: 83-98.
- City of Portland. 2009. Willamette Subwatersheds, Willamette River North Segment. City of Portland, Bureau of Environmental Services, Portland, OR. Accessed May, 2011. Available at <http://www.portlandonline.com/bes/watershedapp/index.cfm?action=DisplayContent&SubWatershedID=29&SectionID=1&SubjectID=3&TopicID=26>.
- DieselNet. 2011. Emission Standards, United States: Nonroad Diesel Engines. October, 2011. Accessed online: <http://www.dieselnets.com/standards/us/nonroad.php>
- Energy Information Administration. 2004. Biodiesel Performance, Costs, and Use. October, 2011. Accessed online: <http://www.eia.gov/oiaf/analysispaper/biodiesel/>
- EPA. 2004. Guidelines for Water Reuse. Risk Management Research. September, 2004. Accessed online: <http://www.epa.gov/NRMRL/pubs/625r04108/625r04108.htm>
- EPA. 2008a. Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites. Technology Primer EPA 542-R-08-002, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. <http://www.clu-in.org/download/remed/green-remediation-primer.pdf>
- EPA. 2008b. Green Remediation Best Management Practices for Excavation and Surface Restoration. EPA Office of Superfund Remediation and Technology Innovation. December, 2008.
- EPA. 2009a. Letter from Chip Humphrey and Eric Blischke of EPA to Bob Wyatt of LWG dated June 17, 2009 regarding EPA Comments on Treatment Beneficial Use Market Survey. Region 10, Oregon Operations Office. Portland OR.
- EPA. 2009b. Green Remediation Best Management Practices: Site Investigation. EPA Office of Superfund Remediation and Technology Innovation. December, 2009.
- EPA. 2009c. Superfund Green Remediation Strategy. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Office of Superfund remediation and Technology Innovation. September 2009. <http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf>

- EPA. 2009d. Region 10 Superfund, RCRA, LUST, and Brownfields Clean and Green Policy. Letter, from Dan Opalski, Director, Office of Environmental Cleanup, Rick Albright, Director, Office of Air, Waste, and Toxics, and Edward Kowalski, Director, Office of Compliance and Enforcement. U.S. Environmental Protection Agency, Region 10. August 13, 2009. [http://yosemite.epa.gov/R10/EXTAFF.NSF/0/bee5cf8b41fe1fd18825761c006bb9fb/\\$FILE/ATTBM7LK/clean\\_and\\_green\\_policy%20R10%208%2013%2009.pdf](http://yosemite.epa.gov/R10/EXTAFF.NSF/0/bee5cf8b41fe1fd18825761c006bb9fb/$FILE/ATTBM7LK/clean_and_green_policy%20R10%208%2013%2009.pdf)
- EPA. 2009e. Principles for Greener Cleanups. Letter, from Mathy Stanislaus, Assistant Administrator, Office of Solid Waste and Emergency Response. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. August 27, 2009. [http://www.epa.gov/oswer/greencleanups/pdfs/oswer\\_greencleanup\\_principles.pdf](http://www.epa.gov/oswer/greencleanups/pdfs/oswer_greencleanup_principles.pdf)
- EPA. 2009f. Green Cleanup Standard Initiative. Project update of September 2009. Accessed in August 2011 at: <http://www.epa.gov/oswer/greencleanups/standard.html>
- EPA. 2010a. Superfund Green Remediation Strategy. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Office of Superfund remediation and Technology Innovation. September 2010. <http://www.epa.gov/superfund/greenremediation/sf-gr-strategy.pdf>
- EPA. 2010b. Green Remediation Best Management Practices: Clean Fuel & Emission Technologies for Site Cleanup. Office of Solid Waste and Emergency Response. August, 2010.
- EPA. 2011a. Introduction to Green Remediation. Quick Reference Fact Sheet. U.S. Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation. May 2011. [http://www.clu-in.org/greenremediation/docs/GR\\_Quick\\_Ref\\_FS\\_Intro.pdf](http://www.clu-in.org/greenremediation/docs/GR_Quick_Ref_FS_Intro.pdf)
- EPA. 2011b. Green Remediation Best Management Practices: Integrating Renewable Energy into Site Cleanup. EPA Office of Superfund Remediation and Technology Innovation. April, 2011.
- EPA. 2011c. National Clean Diesel Campaign (NCDC) Technologies Fuels. Accessed online: <http://www.epa.gov/cleandiesel/technologies/fuels.html>
- EPA. 2011d. Draft Methodology for Understanding and Reducing a Project's Environmental Footprint, EPA Office of Solid Waste and Emergency Response and Superfund Remediation and Technology Innovation, September, 2011.
- Hug Engineering. 2010. Emission Control System (DPF and SCR) from Hug Engineering AG on Dutch Pilot Boats KOMO news clip. Accessed online: <http://www.hug-eng.ch/en-news.html>.
- IHC Merwede. 2010. IHC Merwede and Bredenoord run a sustainable dredging test. Accessed online: <http://www.bredenoord.com/k/en/n94/news/view/10484/400/IHC-Merwede-and-Bredenoord-run-a-sustainable-dredging-test.html>. July 18, 2011
- Integral et al. 2011. Portland Harbor RI/FS Remedial Investigation Report, Draft Final. Prepared for the Lower Willamette Group, Portland, OR. Integral Consulting Inc., Mercer Island, WA; Windward LLC, Seattle, WA; Anchor QEA, LLC; Seattle, WA, Kennedy/Jenks Consultants, Portland, OR. August 29, 2011.

- ITRC. 2011. Green and Sustainable Remediation: State of the Science and Practice. GSR-1. Washington, D.C.: Interstate Technology & Regulatory Council, Green and Sustainable Remediation Team. May 2011. <http://www.itrcweb.org/Documents/GSR-1.pdf>
- National Biodiesel Board. 2011. Biodiesel Emissions Calculator, Note on CO2 Reductions. October, 2011. Accessed online: <http://www.biodiesel.org/tools/calculator/default.aspx?AspxAutoDetectCookieSupport=1>
- National Renewable Energy Laboratory. 2009. Biodiesel Handling and Use Guide, 4th Ed. Accessed online: <http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/43672.pdf>
- Portland Water Bureau. 2011. Resources for Rainwater Harvesting brochure. Accessed online: <http://www.portlandonline.com/water/index.cfm?c=55162>. August 2, 2011.
- Slack, Sarah. 2010. The Incorporation of Ecosystem Services Assessment into the Remediation of Contaminated Sites. For U.S. EPA Office of Solid Waste and Emergency Response. August, 2010.
- Sheldon, Q. S., Gardner, D.J., Pendleton, D., and T. Hoffard. 2001. Timber Production from reclaimed creosote-treated wood pilings: Economic analysis and quality evaluation (Solid Wood Products). Forest Products Journal, Nov-Dec. 2001.
- Simpson, K. W., J. P. Fagnani, R. W. Bode, D. M. DeNicola, and L. E. Abele. 1986. Organism–substrate relationships in the main channel of the lower Hudson River. Journal of the North American Benthological Society 5:41–57.
- SURF. 2009. Sustainable Remediation White Paper: Integrating Sustainable Principles, Practices, and Metrics Into Remediation Projects. David E. Ellis and Paul W. Hadley. 2009
- Thomas, D. W. 1983. Changes in the Columbia river estuary habitat types over the past century. Columbia River estuary data development program. Columbia River estuary study taskforce (CREST). Astoria, Oregon: 51.
- USGBS. 2011. Understanding LEED Version 3: Green Buildings in Context. Accessed online: <http://www.usgbs.org>. August 2, 2011
- Ytsma, Renske. 2008. Limited emissions dredging. Master Thesis. Royal Boskalis Westminster nv.